PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B60R 21/24 — A1

(11) International Publication Number: WO 00/03898

(43) International Publication Date: 27 January 2000 (27.01.00)

(21) International Application Number: PCT/GB99/02051

(22) International Filing Date: 30 June 1999 (30.06.99)

(30) Priority Data:
9815115.2 14 July 1998 (14.07.98) GB

(71) Applicant *(for all designated States except US)*: ROVER GROUP LIMITED [GB/GB]; International Headquarters, Warwick Technology Park, Warwick CV34 6RG (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: KARIMI, Homayoun [GB/GB]; 24 Nicholson Close, Warwick CV34 5HB (GB).

(74) Agents: BURRAGE, David, John et al.; Rover Group Limited, Patent Dept., Gaydon Test Centre, Banbury Road, Lighthorne, Warwick CV35 0RG (GB).

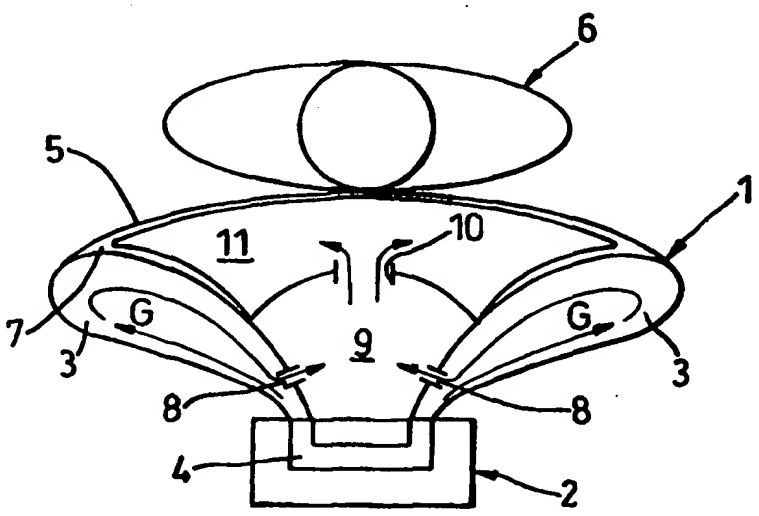
(81) Designated States: DE, GB, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: AN AIRBAG

(57) Abstract

An airbag (1) is provided which comprises a plurality of airbag compartments (3, 9, 11) coupled together with vents (8, 10) such that these airbag compartments (3, 9, 11) are sequentially inflated upon deployment. A first airbag compartment (3) is inflated angularly but under the control of a control member (5) to define an engagement front for contact with a vehicle occupant (6). The first airbag compartment (3) in association with the control member (5) defines a deployment cone within which the other airbag compartments (9, 11) are sequentially inflated to progressively engage the occupant (6) in a less aggressive manner than previous airbag configurations. Typically, the vents (8, 10) are arranged such that there is indirect inflation of the airbag compartments (9, 11) and so further regulation of airbag (1) deployment.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

AN AIRBAG

The present invention relates to an airbag and more particularly to an airbag for a motor vehicle in order to protect an occupant of that vehicle from injury in a traffic accident.

The use of airbags within motor vehicles in order to provide for vehicle occupant protection during road traffic accidents has become relatively commonplace. It will be appreciated that airbags must be rapidly deployed in order to be effective and therefore relatively aggressive inflation of the airbag must be precipitated upon detection of an accident. Unfortunately, a consequence of such relatively violent deployment of air bags is that an occupant may be injured by the airbag itself due to unexpected occupant positioning.

In view of the above, considerable effort has been made with regard to diminishing the aggressive nature of airbag deployment. However, and inherently, reduction in aggressive inflation will reduce deployment speed and therefore may render the airbag, either fully or partially, ineffective.

It is an object of the present invention to provide an airbag which is more adaptable to vehicle occupant unexpected positioning without diminishing deployment speed.

In accordance with the present invention there is provided an airbag for a vehicle, the airbag comprising a plurality of bag compartments sequentially coupled with valve vents therebetween to inflate, in use, in succession a first bag compartment coupled to airbag inflation means in order to deploy away from that inflation means with a control member extending from radial portions of that first compartment to define a deployment cone within which the other bag compartments are inflated sequentially upon attainment of a predetermined gas pressure or volume in previous bag compartments in the succession.

Preferably, the control member is a fabric cover or net or tie straps extending across the radial dimensions of the first bag compartment as it is deployed under inflation. Furthermore, the control member may be elastomeric or non-elastomeric or loose about the first bag compartment. The control member may be secured to the first bag compartment or include a shaped lip or overhang to contain the first bag compartment under deployment.

Sequential deployment of respective bag compartments may be dependent upon attainment of the predetermined gas pressure or volume in the immediate previous bag compartment in the succession or all the previous bag compartments in the succession.

The valve vents between bag compartments may comprise one-way pressure relief valves of a diaphragm type. Furthermore, the valve vents may be located in walls of the bag compartment to provide indirect gas pathways and so regulate deployment inflation or deflation to achieve desired airbag deployment and/or inflation retention.

Typically, the first compartment will present a ring or doughnut under inflation with the control member extending from the leading radial edge of that ring or doughnut in order to define the deployment cone therebeneath.

The other bag compartments, i.e. not the first bag compartment may be arranged in a stack along a common axis which extends from the inflation means. Preferably, at least two such bag compartments will be located within the deployment cone of the airbag in use.

An embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a pictorial cross-section of an airbag at a first stage with a first airbag compartment inflated;

Figure 2 is a pictorial plan view of the airbag depicted in Figure 1;

Figure 3 is a pictorial cross-section of an airbag in a second stage of airbag deployment;

Figure 4 is a plan view of the airbag depicted in Figure 3;

Figure 5 is a pictorial cross-section of a fully deployed airbag; and

Figure 6 is a plan view of the airbag depicted in Figure 5.

An airbag is generally deployed from its airbag housing built into a motor vehicle interior in a forward direction towards an occupant. However, the airbag must present a relatively broad contact surface in order to fully protect and engage an occupant during a traffic accident. Clearly, such broad engagement requires a relatively voluminous airbag, both in terms of the width of engagement and depth of the airbag to facilitate good occupant protection.

Unfortunately, inflation with sufficient rapidity of a large voluminous airbag necessitates a relatively aggressive gas inflation mechanism. Such aggressive deployment can be relatively intolerant to occupant misalignment from the expected and to variation in occupant type. For example, if the occupant should be leaning out of their seat at the time of collision or if the seat is unusually close to the airbag housing or a

large/small adult is the occupant. It will be appreciated that airbag design is based upon average occupant requirements and so deviations from those predicted averages can precipitate occupant injury during the airbag deployment itself.

In accordance with the present invention a multi-compartment airbag is provided. Thus, in the drawings, an airbag 1 is illustrated sprouting under deployment from an airbag housing 2 which is normally located within a vehicle interior. In Figures 1 and 2, a first stage of airbag 1 deployment is depicted during which only a first bag component 3 is inflated by airbag deployment apparatus 4 in the housing 2. Typically, this airbag deployment apparatus 4 will comprise a gas inflation arrangement in which a pyrotechnic solid propellant is ignited to rapidly produce gas for inflation of the airbag 1.

During this initial first stage of airbag 1 deployment, inflation gas is only provided to the first airbag compartment 3 in order to create a ring or doughnut-like configuration as depicted in Figure 2. This ring is defined by a control member 5 which controls radial expansion of the first airbag compartment 3. Typically, the control member 5 will comprise a fabric cover or net or tie straps between the radially expanding edges of the compartment 3. Thus, a relatively broad engagement front is provided by the airbag 1 upon which an occupant of a vehicle can be engaged.

It will be appreciated that in this initial airbag inflation stage, only the first airbag compartment 3 is deployed and this provides a more angular approach to a vehicle occupant 6. Thus, for comparison it will be appreciated that previous airbag deployments have substantially presented an aggressive inflation in the direction of arrow head A straight at the occupant 6 whilst, the present airbag initially propels the airbag in the form of the first airbag compartment 3 in the direction of arrow heads B. Thus, the occupant 6 is subjected to less of a frontal "punch" or assault from the airbag, but rather an encompassing embrace with the control member 5 enveloping the front of the occupant 6.

Within the ring or doughnut configuration of the inflated first compartment 3 a deployment cone 7 is defined. Furthermore, it will be understood that the combination of the first airbag compartment 3 and the control member 5 will generally be insufficient to absorb occupant 6 energy or protect that occupant 6 during a traffic accident. Thus, in accordance with the present invention, this deployment cone 7 is filled with further airbag compartments in a consecutive and sequential manner in order to appropriately engage the occupant 6.

The initial inflation gas of the apparatus 4 is propelled into the compartment 3 in the direction of arrow heads G in order to appropriately rapidly inflate this compartment 3. When the compartment 3 is sufficiently

inflated or upon sufficient pressurisation due to engagement with the occupant 6, the vent valves 8 are opened or exposed in order to allow inflation and so deployment of a second airbag compartment 9 into the deployment cone 7.

Figures 3 and 4 illustrate the airbag 1 during inflation of the second airbag compartment 9. It will be appreciated that the occupant 6, although depicted as still in a displaced position relative to the airbag 1, will generally by this stage impinge upon the control member 5 and therefore be partly enveloped by the airbag 1. The occupant 6 and control member 5 are shown separated for clarity.

It will be noted that the airbag deployment inflation gas from the apparatus 4 passes through the first compartment 3 into the second compartment 9 via the vents 8. Thus, there is an indirect inflation to the second airbag compartment 9 which in itself regulates the speed or time delay with which the second airbag 9 is inflated within the airbag deployment sequence. As the second airbag 9 is inflated, it would be appreciated that it more gradually moves towards the occupant 6 in order to engage that occupant 6 than the first compartment 3 previously.

As the second airbag compartment 9 must fill the deployment cone 9, it will be appreciated that generally the volume of inflation gas to achieve the

same displacement length towards the occupant 6 in comparison with the first compartment 3 will be greater. Thus, the speed with which the second airbag 9 approaches the occupant 6 will be lower than the deployment speed of the first compartment 3. Such less aggressive engagement with the occupant 6 will be more acceptable in terms of diminishing the possibility of airbag induced injury to the occupant 6.

It will be appreciated that the second airbag 9 in the embodiment depicted in the drawing, will act as the sturdy or substantial base of the airbag 1 with the first airbag 3 projecting outwardly from that sturdy base of the second airbag compartment 9 in order to provide an embracing front to the occupant 6. In such circumstances, normally the occupant 6 will, in accordance with an idealised scenario, have contacted the control member 5 and after inflation of the second airbag compartment 9 will be arranged whereby the chest of the occupant 6 is engaged by the compartment 9 whilst the shoulders of the occupant 6 are engaged by the first compartment 3. Upon such engagement, a final valve 10 is opened or exposed in order to inflate a third airbag compartment 11 which fills the remaining volume of the deployment cone 7. This third airbag compartment 11 essentially compresses the occupant 6 into a vehicle seat to resiliently hold that occupant 6 during the violence of a vehicle collision.

Figures 5 and 6 illustrate the airbag 1 in full deployment.

It will be noted that the inflation gas from the airbag deployment apparatus 4 passes through the first airbag compartment 3 into the second airbag compartment 9 via vents 8 and then subsequently into the third airbag compartment 11 through vent 10. Thus, inflation of the airbag compartments 3, 9, 11 is consecutive and successive and furthermore indirect in order to regulate airbag inflation rate as required. The third airbag compartment 11 fills the remainder of the deployment cone 7 in order to fully engage the occupant 6 and so provide protection during a traffic accident,

Those skilled in the art will also appreciate that due to the indirect labyrinthine inflation gas pathway through vents 8, 10 that deflation of the airbag 1 will be reduced such that the occupant 6 may be protected for a longer period from secondary collisions in a vehicle accident as the airbag 1 will remain substantially inflated for a longer period of time.

The purpose of the third airbag compartment 11 as indicated previously is to provide final engagement with the occupant 6. However, it will be appreciated due to the indirect nature of inflation via vents 8 and 10, that the force or aggression of inflation for the third compartment 11 will be significantly less than that for previous compartments 3, 9 in the succession. This less aggressive inflation of the third compartment 11

should diminish the percussive shock to the occupant 6 of airbag 1 deployment and so injury to that occupant 6.

Normally, the vent 10 is located centrally within the wall between the second compartment 9 and the third compartment 11 in order to propel inflation gas directly towards the occupant 6. Such direct propulsion of the inflation gas towards the occupant 6 imitates previous single airbag compartment constructions but in the present airbag 1, it will be appreciated that the force of inflation gas propulsion is diminished by the indirect inflation route through the first compartment 3 and the second compartment 9.

As indicated previously, a pyrotechnic gas generation mechanism is generally used with regard to the airbag deployment apparatus 4. Such pyrotechnically generated inflation gas is typically very hot. Thus, it will be appreciated, that the cooling effects of indirect inflation to the final third airbag compartment 11, which is that substantially in relatively long term contact with the occupant 6, will again reduce potential problems of direct contact of hot inflation gas with the occupant 6 with the inherent possibility of burn injuries to that occupant 6.

A control element 5 is necessary in order to confine the first airbag compartment 3 under inflation within a desired engagement front. It will

be appreciated, that the first airbag compartment 3 is substantially angularly projected from the housing 2 and so could easily be deflected over a broader than desirable engagement front. The function of the control member 5 is to limit and retain the engagement front presented to the occupant 6. Typically, the control member 5, as indicated previously, could comprise a fabric cover or net or straps extending from the peripheral portions of the compartment 3. Furthermore, the control member 5 could be elastic or fixed or loose as required. Thus, an elastic control member 5 would expand in accordance with its elastic limits to define the engagement front. A fixed control member simply allows the compartment 3 to expand until inhibited by the control member 5. A loose control member 5 would simply act through friction in order to slow radial expansion until the airbag 1 engages the occupant 6 whereupon inflation of the second compartment 9 will begin with the inherent reduction in inflation gas to the first compartment and so restrain broader engagement front development through inflation gas lost by diversion to that compartment 9. It will also be understood that the control member 5 could comprise a loose cover with overhanging valence or shaped lips into which the first compartment 3 expands.

Normally, the vents 8, 10 will comprises one-way pressure relief valves normally of a simple diaphragm type.

Although single sequential compartments 3, 9, 11 are illustrated in the drawings, it will be appreciated by those skilled in the art that a cascade of airbag compartments could be envisaged whereby a single airbag compartment could through appropriate vent valves feed two or more subsequent compartments in order to best engage an occupant. Thus, a third compartment 11 could be split into two parallel compartments about the centre of the airbag 1 such that the second compartment 9 feeds both such airbag compartments through respective vents. In such circumstances, it will be appreciated that occupant 6 mis-alignment may be adjusted through natural pressure equalisation between these two parallel airbag compartments.

Although development of the first airbag compartment has been described as a cone, it will be appreciated that other hollow funnel like configurations such as a pyramid or other shape which presents a polygon or oval base front for presentation to an occupant which tapers or narrows to a more focused vertex upon which it is secured to the inflation mechanism, could be used. Thus, those skilled in the art will appreciate that the term cone includes these other configurations of the first airbag compartment.

In order to further define the first compartment additional control members may be located within and across the 'cone' of that first

compartment provided these control members do not interfere with deployment of subsequent airbag compartments in the succession.

CLAIMS

1. An airbag (1) for a vehicle, the airbag (1) comprising a plurality of bag compartments (3, 9, 11), the airbag (1) characterised in that the bag compartments (3, 9, 11) are consecutively coupled with vents (8, 10) therebetween to inflate in succession, a first bag compartment (3) coupled to airbag inflation means (4) to sprout from that inflation means (4) with a control member (5) extending from peripheral portions of that first compartment (3) to define a deployment cone within which the other bag compartments (9, 11) are inflated sequentially upon attainment of a predetermined inflation gas pressure or volume in previous bag compartments (3, 9, 11) in the succession.

2. An airbag (1) as claimed in Claim 1, wherein the control member (5) is a fabric cover or a net or a plurality of tie straps.

3. An airbag (1) as claimed in Claim 1 or Claim 2, wherein the control member (5) is fixed or elastic or loose.

4. An airbag (1) as claimed in any of Claims 1, 2 or 3, wherein the vents (8, 10) are configured to operate dependent upon inflation gas pressure or volume in the immediate previous bag compartment (3, 9, 11) in the succession.

5. An airbag (1) as claimed in any preceding claim, wherein the vents (8, 10) comprise one-way pressure relief valves.

6. An airbag (1) as claimed in any preceding claim, wherein the vents (8, 10) are arranged within the airbag compartment (3, 9, 11) walls in order to provide an indirect inflation gas path and so regulate airbag (1) inflation to ensure proper deployment and/or inflation retention.

7. An airbag (1) as claimed in any preceding claim, wherein the first airbag compartment (3) provides upon inflation, a ring or doughnut configuration with the control member (5) extending from radial peripheral portions of that first compartment (3).

8. An airbag (1) as claimed in any preceding claim, wherein airbag compartments (9, 11), other than the first airbag compartment (3) are stacked about a common axis of the airbag (1) extending from the airbag inflation means (4).

9. A motor vehicle including an airbag (1) as claimed in any preceding claim.

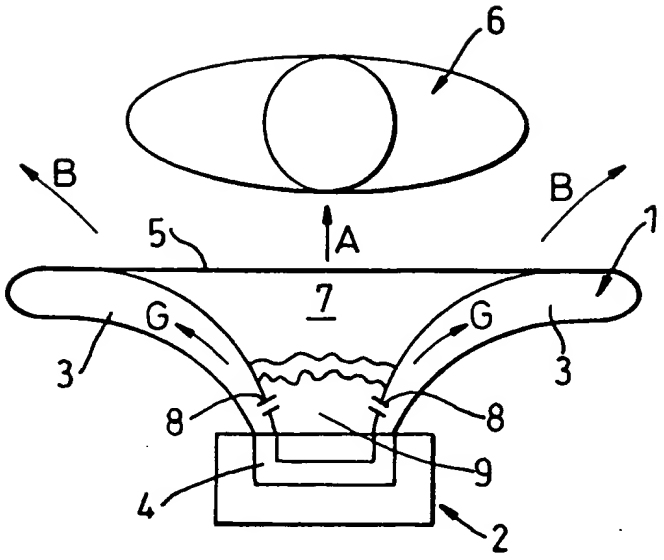


Fig. 1

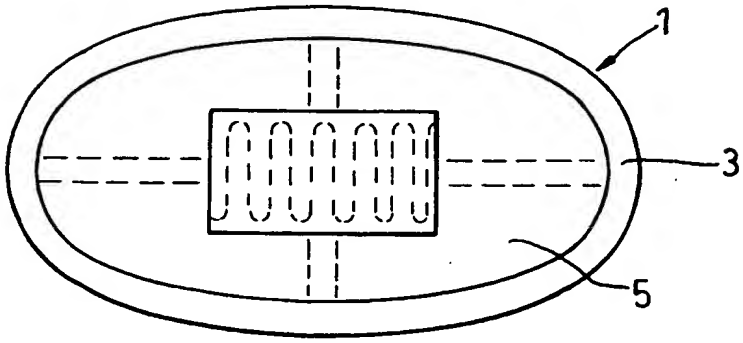


Fig. 2

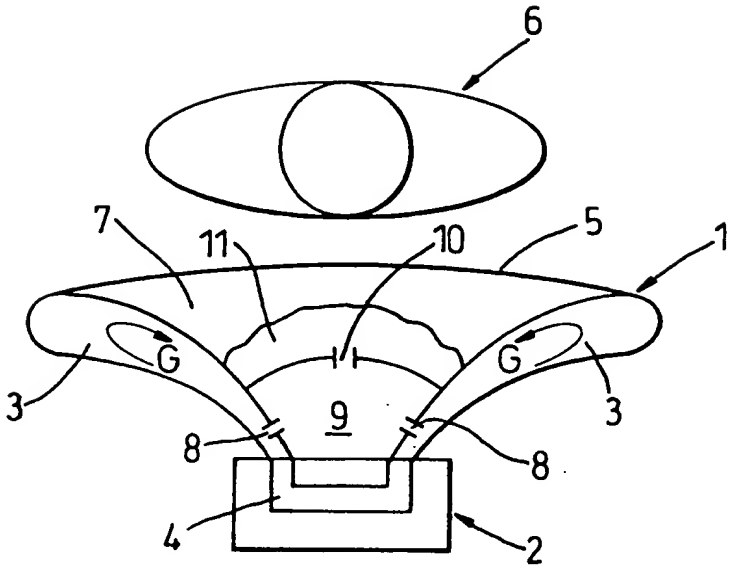


Fig. 3

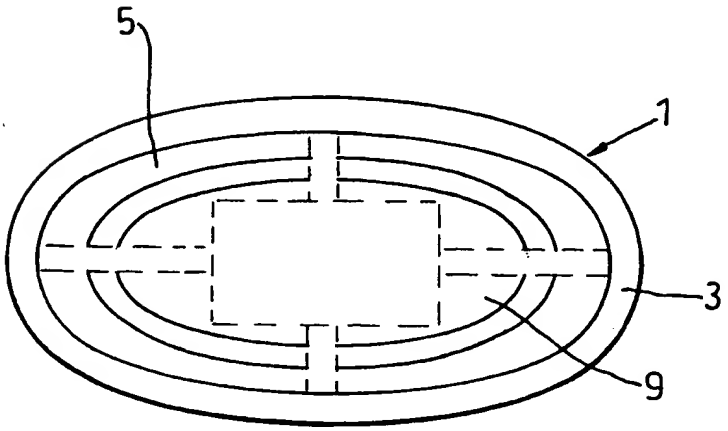


Fig. 4

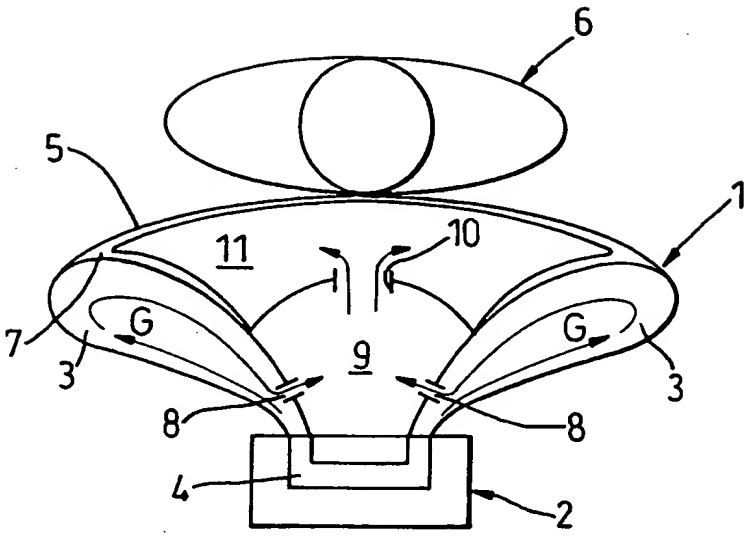


Fig. 5

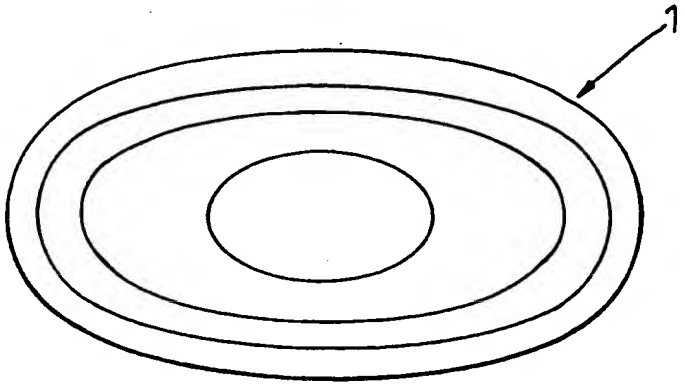


Fig. 6

INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/GB 99/02051

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R21/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 90 09908 A (AUTOMOTIVE TECHNOLOGIES INT., INC.) 7 September 1990 (1990-09-07) page 4, line 8 page 12, paragraph 3; figure 10 ---	1-3,6,7, 9
A	DE 22 48 393 A (FORD-WERKE AG) 26 April 1973 (1973-04-26) page 2, paragraph 2 -page 5; figures ---	1-3,6,7, 9
A	DE 92 11 421 U (TRW REPA GMBH) 21 January 1993 (1993-01-21) page 4, paragraph 2 - paragraph 3; figure 1 --- -/--	1-7,9

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 October 1999	19/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dubois, B

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/GB 99/02051

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 812 741 A (HS TECHNIK UND DESIGN TECHNISCHE ENTWICKLUNGEN GMBH) 17 December 1997 (1997-12-17) column 9, line 11 - line 24; figure 4A column 10, line 35 -column 11, line 52; figures 5,8,12 column 12, line 42 - line 53 ---	1-4,6,8, 9
A	US 3 614 127 A (P.M. GLANCE) 19 October 1971 (1971-10-19) column 2, line 26 -column 3, line 13; figures -----	1,6,8,9

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

...rmation on patent family members

Intern ...al Application No
PCT/GB 99/02051

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9009908 A	07-09-1990	NONE	
DE 2248393 A	26-04-1973	CA 991218 A	15-06-1976
		GB 1338214 A	21-11-1973
		JP 48050437 A	16-07-1973
		US 3752501 A	14-08-1973
DE 9211421 U	21-01-1993	EP 0584782 A	02-03-1994
		JP 6340242 A	13-12-1994
EP 812741 A	17-12-1997	DE 19611384 A	25-09-1997
		DE 19707997 A	03-09-1998
		EP 0861762 A	02-09-1998
US 3614127 A	19-10-1971	NONE	